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Nagazumi

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[54] **MULTI-STEP SPREAD SPECTRUM COMMUNICATION APPARATUS**

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[51] **Int. Cl.**[4] **H04B 7/02**

[52] **U.S. Cl.** **375/1**; 380/34

[58] **Field of Search** 371/1; 364/717; 380/34, 380/46; 331/78

[56] **References Cited**

U.S. PATENT DOCUMENTS

3,665,472	5/1972	Kurtchner et al.	375/1
3,706,933	12/1972	Bidell et al.	325/479
3,808,536	4/1974	Reynolds	371/1
4,225,935	9/1980	Zscheile, Jr. et al.	375/1
4,241,447	12/1980	Epstein	371/1
4,255,791	3/1981	Martin	371/1
4,308,617	12/1981	German, Jr.	371/1
4,475,215	10/1984	Gutleber	375/1
4,494,238	1/1985	Groth, Jr.	375/1
4,538,281	8/1985	Rajan	375/2.2
4,597,087	6/1986	Kadin	375/1
4,606,039	8/1986	Nicolas et al.	375/1
4,607,375	8/1986	Lee	375/1

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[57] **ABSTRACT**

In a pseudo-random communication system, a transmitter-generated encoded signal is to be correlated with a receiver-generated similarly encoded signal for recognizing synchronization of the transmitted and received signals in the presence of undesired received energy. The system comprises a spread-spectrum transmitter including at least two pseudo-noise generators for producing at least two pseudo-noise signals which are related in a predetermined fashion, a mixer for receiving and mixing the two pseudo-noise signals with respective carrier and information signals to produce an output signal, and apparatus for transmitting the output signal. The system also includes a spread-spectrum receiver comprising a correlator and a matched filter coupled in circuit to form a synchronization detector circuit for receiving and detecting the encoded output signal transmitted by the transmitter so as to recover the information therefrom. The correlator includes at least one pseudo-noise generator for producing pseudo-noise signals related in a predetermined fashion to the pseudo-noise signals produced by the transmitter pseudo-noise generators and a mixer for mixing the pseudo-noise signals with the received encoded output signals and coupled in circuit with the matched filter circuit.

21 Claims, 7 Drawing Sheets